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THE EFFICIENCY OF THE ISEQ INDEX: EMPIRICAL TESTS USING DAILY DATA

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ABSTRACT

This paper examines the efficiency of the Dublin stock market over the period 1987 to 1997. Using a variety of techniques the efficiency of both the ISEQ index and an equally weighted portfolio of large capitalisation stocks is re-assessed. The findings indicate that the market is not weak-form efficient, with strong evidence of persistence in the return behaviour of the data. Evidence with regard to seasonal anomalies confirms the presence of a January effect. However, the evidence with regard to a possible Tuesday effect is not significant in the period after 1991.

INTRODUCTION

The analysis of the efficiency of the Irish equity market has generally been supportive of the hypothesis that the market is not weak-form efficient. Papers such as McKillop and Hutchinson (1988), Donnelly (1991) and Lucey (1994) found evidence of persistence and seasonal behaviour in the return behaviour of the Irish Stock Exchange Equity (ISEQ) index. A shortcoming of previous papers has been the sole use of the ISEQ index. Studies such as Lo and MacKinlay (1988 and 1990) show that the use of index data in efficiency tests can be severely biased in the presence of non-synchronous trading, which is a common problem on the small and illiquid Irish market. This study has two primary aims: firstly, to re-examine the efficiency of the ISEQ index and, secondly, to analyse an equally weighted index of five of the most heavily traded firms on the Dublin exchange. This section of the study should allow a preliminary analysis of whether previous studies have overestimated the inefficiencies present in the Dublin exchange through the use of index data.

In addition to autocorrelation and runs tests, this study also utilises more recent empirical advances and uses unit root and variance ratio tests. With regard to the variance ratio tests, the approach proposed by Lo and MacKinlay (1988) is adopted in this study, with both the original and heteroscedasticity-consistent statistics being calculated. Finally, seasonality is re-examined in order to see if any structural changes have occurred to the market following the relaxation of exchange controls and the separation from the London Stock Exchange. The remainder of the paper is laid out as follows. The following section details the data used in this study and reports the summary statistics. The next two sections present the empirical findings with respect to weak-form efficiency and seasonality respectively. The final section provides concluding comments.

DATA AND SUMMARY STATISTICS

The data used in this study is examined on a daily basis over the period 1987 to 1997. The empirical tests are undertaken on two sub-periods, with the end of 1991 as the mid-point. Closing prices are collected for each trading day, with log prices and returns used throughout. The total number of observations in the dataset is 2258. As stated previously, the tests are repeated using an equally weighted index of five of the most heavily traded firms in order to try and minimise the impact of non-synchronous and thin trading. The stocks used in this section of the analysis are Allied Irish Banks, Bank of Ireland, Cement Roadstone Holdings, Jefferson Smurfit and the Kerry Group.

Table 1: Summary Statistics and Properties

	1987-1997	1987-1997[a]	1987-1991	1987-1991[a]	1992-1997
PANEL A: ISEQ Index					
Mean	0.042311	0.055703	0.020569	0.048063	0.062788
Standard Deviation	1.0037	0.9189	1.2212	1.0773	0.74276
Minimum	-12.766	-7.8393	-12.766	-7.8393	-3.4784
Maximum	8.5437	8.5437	8.5437	8.5437	5.8423
N	2567	2548	1245	1226	1322
PANEL B: Equally Weighted Index					
Mean	0.06189	0.07167	0.04782	0.06793	0.07515
Standard Deviation	1.1828	1.1026	1.3990	1.2589	0.9349
Minimum	-15.16	-8.72	-15.16	-8.72	-3.48
Maximum	6.36	6.36	6.36	6.36	6.02
N	2567	2548	1245	1226	1322

Note: [a] Indicates time periods excluding October 1987

Table 1 provides details of the summary statistics of the series examined. As with all of the tests undertaken in this paper, time periods incorporating the 1987 crash are calculated twice, firstly with all available data and, secondly, with the month of October 1987 excluded. This is done in order to prevent the severe price movements of that month biasing the results. One noticeable point from **Table 1** is that the equally weighted index consistently provides higher mean daily returns and variances than the ISEQ index itself. This has a number of implications. Firstly, it is an indication of the impact of thin trading and cross-autocorrelations on the ISEQ index and, secondly, it has implications for fund managers wishing to obtain accurate data on the Irish stock market. The following sections in turn describe each of the techniques used to assess the efficiency of the market and report the empirical results obtained.

EMPIRICAL TESTS

Initially runs tests and the autocorrelation coefficients of the Irish market are examined. Runs tests examine the number of consecutive returns above and below a selected cut-off point. The tests are run twice, once with the mean of the series as the cut-off point and secondly with zero as the cut-off point. The number of runs is then compared against its sampling distribution. The results of the runs tests for both the ISEQ and the equally weighted series are displayed in **Tables 2 and 3**. The results show that the null hypothesis (that there is no pattern) can be rejected at a significance level of 1 per cent for both the ISEQ and equally weighted series. This is the case for all of the time periods examined and for the two alternative cut-off points.

It should be noted that runs tests can be problematic to analyse during periods containing either extended bull or bear markets, indeed this may be a possible explanation for the results contained in this study. The Irish market was one of the strongest performing European equity markets during the time period analysed, and this strong and sustained bull market may be biasing the reliability of the runs tests as an indicator of weak-form efficiency.

Table 2: Runs Tests on the ISEQ Index

	1987-1997	1987-1997[a]	1987-1991	1987-1991*	1992-1997
PANEL A: Mean as Cut-off					
Runs	1063	1055	513	509	545
Cases < Mean	1296	1312	612	623	685
Cases > Mean	1271	1236	633	603	637
Z	-8.7413	-8.6812	-6.2576	-5.9923	-6.3987
2 Tailed P	0.0000	0.0000	0.0000	0.0000	0.0000
PANEL B: Zero as Cut-off					
Runs	1061	1051	519	509	543
Cases < Mean	1218	1208	593	583	625
Cases > Mean	1349	1340	652	643	697
Z	-5.7150	-8.7650	-5.8595	-5.9303	-6.4595
2 Tailed P	0.0000	0.0000	0.0000	0.0000	0.0000

Note: [a] Indicates time periods excluding October 1987

Table 3: Runs Tests on the Equally Weighted Index

	1987-1997	1987-1997[a]	1987-1991	1987-1991[a]	1992-1997
PANEL A: Mean as Cut-Off					
Runs	1102	1098	547	541	558
Cases < Mean	1333	1332	638	638	694
Cases > Mean	1234	1217	607	589	628
Z	-7.1408	-6.9442	-4.3187	-4.1490	-5.6463
2 Tailed P	0.0000	0.0000	0.0000	0.0000	0.0000
PANEL B: Zero as Cut-Off					
Runs	1097	1087	545	535	553
Cases < Mean	1224	1216	599	591	625
Cases > Mean	1343	1333	646	636	697
Z	-7.3097	-7.3778	-4.4073	-4.4999	-5.9076
2 Tailed P	0.0000	0.0000	0.0000	0.0000	0.0000

Note: [a] Indicates time periods excluding October 1987

The second test of weak-form efficiency analyses the autocorrelation coefficients of the two series, with the results for both the ISEQ and the heavily traded stocks reported in **Table 4**. Given a covariance stationary series, the kth order autocorrelation coefficient for a series r can be defined as:

$$\rho(k) = \frac{\operatorname{cov}(r_t, r_{t+k})}{\sqrt{\sigma^2_{r_t}}\sqrt{\sigma^2_{r_{t+k}}}} = \frac{\operatorname{cov}(r_t, r_{t+k})}{\sqrt{\sigma^2_{r_t}}} \tag{1}$$

As with the Lucey (1994) paper, the Bartlett independence method is adopted in the calculation of the standard errors, as the two series examined are not white noise. In addition, the Box Ljung Portmanteau Q statistic is calculated, which can be displayed as follows:

$$Q_k = T(T+2)\sum_{m=1}^{k} \frac{\rho^2(k)}{T-k} \tag{2}$$

Table 4: Autocorrelation Coefficients, 1987-1997

	ISEQ Index			Equally Weighted Index		
	ρ	SE	*Q*	ρ	SE	*Q*
1	0.184	0.020	86.730***	0.103	0.020	27.509***
2	0.069	0.020	99.040***	0.049	0.020	33.579***
3	0.010	0.020	99.315***	-0.021	0.020	34.686***
4	0.048	0.020	105.323***	0.026	0.020	36.446***
5	0.078	0.021	121.090***	0.034	0.020	39.481***
6	0.068	0.021	133.148***	0.001	0.020	39.486***
7	0.024	0.021	134.681***	0.009	0.020	39.681***
8	0.054	0.021	142.213***	0.003	0.020	39.704***
9	0.039	0.021	146.189***	0.006	0.020	39.784***
10	0.090	0.021	167.123***	0.055	0.020	47.673***
11	0.030	0.021	169.445***	0.023	0.020	49.002***
12	0.012	0.021	169.806***	-0.009	0.020	49.212***
13	-0.011	0.021	170.121***	-0.019	0.020	50.115***
14	0.014	0.021	170.602***	0.003	0.020	50.134***
15	0.021	0.021	171.784***	-0.014	0.020	50.176***
16	-0.032	0.021	174.445***	-0.009	0.020	50.388***
17	0.016	0.021	175.084***	0.027	0.020	52.331***

18	-0.036	0.021	178.354***	-0.024	0.020	53.799***
19	0.000	0.021	178.355***	-0.016	0.020	54.482***
20	0.035	0.021	181.521***	0.020	0.020	55.479***
40	-0.025	0.021	230.800***	-0.003	0.020	85.501***
60	0.080	0.022	265.735***	0.021	0.021	126.235***
80	0.070	0.022	291.762***	0.001	0.021	144.985***
100	-0.012	0.022	316.170***	-0.018	0.021	160.702***
150	0.008	0.022	365.518***	-0.007	0.021	200.597***
200	0.029	0.022	442.249***	0.026	0.022	272.637***

Notes:

ρ indicates the autocorrelation coefficient, SE is the standard error and Q is the Box-Ljung Portmanteau statistic
*** Indicates significance at 1 per cent level

The null hypothesis is that $\rho_i = \rho_j = 0$ for all values of i and j, while the statistic is χ^2 with k degrees of freedom. The Portmanteau Q is reported together with the autocorrelations for a variety of lags. The results for the ISEQ support the findings of Lucey (1994), with high degrees of autocorrelation found in the series. In addition, the null hypothesis of the Portmanteau Q statistic, that the autocorrelation coefficients are independent with zero mean, can be rejected at a 1 per cent level for all of the lag lengths examined. The results for the two sub-periods also support these findings, as do the tests for the periods excluding the 1987 crash[1]. The results for the equally weighted portfolio are again similar, with significant Portmanteau Q statistics for all lags. However, it is noticeable that in the case of most of the lag lengths, the autocorrelation coefficient is lower than that found with respect to the ISEQ. As with the runs tests, the strong performance of the Irish market over the time period examined may be a biasing factor in the results reported.

Unit root tests have been frequently used to test for random walks in time-series data. It should be noted that while the random walk model is a subset of the unit root null hypothesis, they have a different focus. As Lo and MacKinlay (1989) note, while unit root tests propose the null hypothesis that the series is not a random walk, random walk tests have as their null that the stationary component does not exist. Initially tests for the stationarity of the two series are undertaken using the Augmented Dickey-Fuller (ADF) unit root tests. The ADF test is used to test for the presence of a unit root and can be defined as:

$$\Delta P_t = \alpha_0 + \alpha_1 P_{t-1} + \alpha_2 t + \sum_{j=1}^{p} \gamma_j \Delta P_{t-j} + \varepsilon_t \tag{3}$$

Where P is the series examined, t is a trend variable and ε_t is assumed to be Gaussian white noise. An alternative test for the presence of unit roots is the Philips-Peron method which uses a non-parametric correction for autocorrelation. As the Philips-Peron procedure corrects for autocorrelation through the use of the Bartlett window, the method is robust to any time-dependent heteroscedasticity as well as autocorrelation. Both unit root tests are conducted on the level and return series and are displayed in **Tables 5 and 6**. Note that the critical values are identical for both types of test.

In the majority of cases the null hypothesis of the presence of a unit root in the price series cannot be rejected. However, with respect to the returns the null is rejected in all cases, thus suggesting that the returns for the ISEQ are stationary. The findings for the equally weighted portfolio differ quite substantially, with the null rejected in the majority of cases for the price series. It should however be noted that the presence of a random walk component in stock returns does not necessarily imply that the returns are unpredictable. As Campbell, Lo and MacKinlay (1997) note, as there are non-random walk components in the null hypothesis for unit root tests such tests are designed to examine whether returns are predictable or not.

Table 5: Unit Root Tests on the ISEQ Index

	1987-1997	1987-1997[a]	1987-1991	1987-1991[*]	1992-1997
PANEL A: Levels					
ADF	-0.8777	-2.5849	-3.6276	-2.8570	-2.5335
ADF with Trend	-1.8676	-2.4836	-2.4533	-1.9209	-4.0077
ADF: Trend and Drift	-2.0231	-1.5610	-3.6740	-2.5443	-3.6111
Philips-Peron	-1.8991	-4.4833*	-2.3740	-5.2217*	-4.0517*
PP with Trend	-1.8570	-3.5376	-1.7322	-3.7147	-4.5045*
PP: Trend and Drift	-0.8998	-1.4281	-2.4610	-4.5653	-2.9860
PANEL B: Returns					
ADF	-26.887*	-22.456*	-14.553*	-15.276*	-15.604*
ADF with Trend	-18.310*	-15.052*	-9.7535*	-10.792*	-10.943*
ADF: Trend and Drift	-27.463*	-22.571*	-14.627*	-16.180*	-16.397*
Philips-Peron	-883.39*	-871.15*	-436.33*	-428.07*	-435.43*
PP with Trend	-588.97*	-580.55*	-291.69*	-287.64*	-291.06*
PP: Trend and Drift	-883.46*	-870.82*	-437.53*	-431.46*	-436.59*

Notes:

[a] Indicates time periods excluding October 1987

* Indicates significance at a 10 per cent level

The critical values for the base test are 3.78, with trend 4.03 and 5.34 for trend and drift

Table 6: Unit Root Tests on the Equally Weighted Index

	1987-1997	1987-1997[a]	1987-1991	1987-1991[a]	1992-1997
PANEL A: Levels					
ADF	-4.4532*	-5.0285*	-12.371*	-1.8860	-5.4410*
ADF with Trend	-3.5382	-3.3706	-9.4451*	01.4615	-5.9275*
ADF: Trend and Drift	-1.9950	-1.5095	-13.117*	-1.7376	-4.2210*
Philips-Peron	-5.8223*	-6.4711*	-12.198*	-2.8776	-5.1382*
PP with Trend	-4.2734*	-4.6169*	-9.3679*	-1.9211	-5.5595*
PP: Trend and Drift	-1.6542	-1.3045	-13.052*	-1.8372	-3.6435
PANEL B: Returns					
ADF	-24.643*	-23.446*	-13.954*	-15.688*	-16.880*
ADF with Trend	-16.659*	-15.663*	-9.3776*	-10.833*	-11.481*
ADF: Trend and Drift	-24.979*	-23.482*	-14.060*	-16.240*	-17.212*
Philips-Peron	-1041.2*	-967.79*	-543.31*	-490.34*	-460.42*
PP with Trend	-693.88*	-645.01*	-362.70*	-328.47*	-306.93*
PP: Trend and Drift	-1040.8*	-967.52*	-544.05*	-492.70*	-460.39*

Notes:

[a] Indicates time periods excluding October 1987

* Indicates significance at a 10 per cent level

The critical values for the base test are 3.78, with trend 4.03 and 5.34 for trend and drift

The final set of statistics calculated in the initial examination of the efficiency of the Irish market are variance ratios. The approach adopted in this study is in the spirit of that proposed by Lo and MacKinlay (1988). The variance ratio tests exploit the fact that the variance of the increments of a random walk is linear in the sampling function. Therefore if a series is a random walk, the variance of the *k*th difference of the series will be *k* times the size of the variance of the first difference variable. Therefore, if the data is split into *nk+1* equally spaced intervals, $P_0, P_1, P_2, \ldots, P_{nk}$, then the ratio of *1/k* of the variance of $P_t - P_{t-k}$ is expected to be equal to the variance of $P_t - P_{t-1}$, i.e. unity. This can be represented as:

$$VR(k) = \frac{\sigma_k^2}{\sigma_a^2} \tag{4}$$

Where σ_k^2 is an unbiased estimator of one *k*th of the variance of $\ln P_t - \ln P_{t-k}$ and σ_a^2 is the unbiased estimator of the variance of $\ln P_t - \ln P_{t-1}$. The estimators can be defined and derived as follows:

$$\sigma_k^2 = \frac{1}{M}\sum_{t=k}^{T}(P_t - P_{t-k} - k\hat{\mu})^2 \tag{5}$$

$$\sigma_a^2 = \frac{1}{N-1}\sum_{t=k}^{T}(P_t - P_{t-1} - \hat{\mu})^2 \tag{6}$$

Where:

$N = \text{Sample Size}$

$P_0, P_1, P_2, \ldots, P_{nk} = \text{Log Prices}$

$M = k(N-k+1)\left(1-\frac{k}{N}\right)$

$\hat{\mu} = \frac{1}{N}(P_N - P_0)$

$\hat{\mu}$ and σ_k^2 are the standard sample estimators of the mean and variance and the maximum likelihood estimators of μ and σ^2. Lo and MacKinlay (1989) show that the variance ratio statistic asymptotically approaches normality:

$$Z(k) = \frac{VR(k)-1}{\sqrt{\Phi(k)}} \xrightarrow{a} N(0,1) \tag{7}$$

Where $\Phi(k)$ denotes the variance ratio's asymptotic variance, which can be defined as:

$$\Phi(k)=\frac{2(2k-1)(k-1)}{3k} \sim N(0,1) \tag{8}$$

Lo and MacKinlay (1988) also derive a heteroscedasticity consistent variance estimator $\Phi^*(k)$, due to the potential problems that would arise with the random walk hypothesis being rejected due to stock returns being conditionally heteroscedastic with respect to time. The heteroscedasticity consistent test statistic, $Z^*(k)$, is calculated in the same manner as previously:

$$Z^*(k)=\frac{VR(k)-1}{\sqrt{\Phi^*(k)}} \xrightarrow{a} N(0,1) \tag{9}$$

Where $\Phi^*(k)$ denotes the variance ratio's asymptotic variance, which can be defined as:

$$\Phi^*(k)=\sum_{j=1}^{k-1}\left[\frac{2(k-j)}{k}\right]\delta(j) \tag{10}$$

Where:

$$\delta(j)=\frac{\sum_{t=j+1}^{T}(P_t-P_{t-1}-\hat{\mu})^2(P_{t-j}-P_{t-j-1}-\hat{\mu})^2}{\left[\sum_{t=1}^{T}(P_t-P_{t-1}-\hat{\mu})^2\right]^2} \tag{11}$$

Table 7: Variance Ratio Tests

	1987-1997	1987-1997[a]	1987-1991	1987-1991[a]	1992-1997
PANEL A: ISEQ Index					
VR (2)	0.8443	0.8366	0.7998	0.7712	0.8263
Z*(2)	-7.8872***	-8.2523***	-7.0672***	-8.0077***	-6.3150***
VR (4)	0.7407	0.7604	0.6299	0.6064	0.7327
Z*(4)	-7.0196***	-6.4651***	-6.9763***	-7.3690***	-5.1918***
VR (8)	0.6319	0.7315	0.4501	0.4516	0.6894
Z*(8)	-6.2972***	-4.5799***	-6.5463***	-6.4836***	-3.8097***
VR (16)	0.5115	0.6462	0.2918	0.2850	0.6963
Z*(16)	-5.6080***	-4.0481***	-5.6471***	-5.6624***	-2.4956**
VR (32)	0.4399	0.5541	0.1891	0.1676	0.6289
Z*(32)	-4.4227***	-3.5097***	-4.4332***	-4.5188**	-2.0915**
VR (64)	0.4312	0.5434	0.1195	0.0958	0.5440
Z*(64)	-3.1183***	-2.4951***	-3.3188***	-3.3835***	-1.7767*
PANEL B: Equally Weighted Index					
VR (2)	0.9055	0.8794	0.9351	0.8972	0.8499
Z*(2)	-4.7856***	-6.0894***	-2.2919**	-3.6037***	-5.4587***
VR (4)	0.8376	0.8236	0.8673	0.8482	0.7808

Z*(4)	-4.3959***	-4.7611***	-2.5001**	-2.8423***	-4.2579***
VR (8)	0.7805	0.8116	0.7679	0.8079	-2.5585
Z*(8)	-3.7546***	-3.2127***	-2.7629***	-2.2706**	-8.7500***
VR (16)	0.7170	0.7730	0.6463	-0.6929	-0.8998
Z*(16)	-3.2483***	-2.5977***	-2.8204***	-2.4323**	19.3750
VR (32)	0.6558	0.6980	0.5654	0.5807	-0.7470
Z*(32)	-2.7181***	-2.3774**	-2.3760**	-2.2763	40.6875
VR (64)	0.6427	0.7011	0.5314	0.5449	-0.6792
Z*(64)	-1.9587*	-1.6335	-1.7661*	-1.7029*	83/3438

Notes:

[a] Indicates time periods excluding October 1987

*** Indicates significance at a 1per cent level

** Indicates significance at a 5 per cent level

* Indicates significance at a 10 per cent level

The tests were conducted over a variety of lengths of k and over the five time periods specified. A sample of the lag lengths is displayed in Table 7, and it can be seen that all of the ratios are significantly less than unity at a level of 10 per cent or lower. These results are also consistent across the ISEQ and equally weighted series. These findings would therefore indicate that there is evidence of persistence in the returns of the Irish market. In addition, in each case the ratio decreases with the value of k, implying negative autocorrelation for multiperiod returns.

SEASONALITY TESTS

Both Donnelly (1991) and Lucey (1994) found evidence of a Tuesday effect in the Irish market and hypothesised that this could be due to a lagged relationship with London due to factors such as thin trading. This hypothesis is also supported by studies of causal relationships between the Irish and British markets, for example Murray (1996), who found evidence of a significant uni-directional relationship from London to Dublin on a daily basis. The rationale behind re-examining seasonality is that the last published study on the topic, Lucey (1994), analysed data up to 1991. Since this point exchange controls have been withdrawn and the Dublin exchange has become independent. Therefore a further examination of the issue is undertaken to test whether any changes have occurred under this new regime. This section of the paper will initially examine day of the week effects and then proceeds to examine monthly seasonal effects.

Table 8: Mean Daily Returns

	1987-1997	1987-1997[a]	1987-1991	1987-1991[a]	1992-1997
PANEL A: ISEQ Index					
Monday	0.0258	0.0391	0.0891	0.1172	-0.0357
Tuesday	-0.0245	0.0093	-0.1610	-0.0930	0.1102
Wednesday	0.0740	0.0829	0.0535	0.0736	0.0947
Thursday	0.1026	0.1098	0.1038	0.1189	0.0950
Friday	0.0314	0.0315	0.0232	0.0234	0.0413
PANEL B: Equally Weighted Index					
Monday	0.0366	0.0344	0.1189	0.1158	-0.0432
Tuesday	0.0482	0.0828	-0.0444	0.0264	0.1447
Wednesday	0.0740	0.0904	0.0428	0.0764	0.1098
Thursday	0.1149	0.1166	0.1076	0.1111	0.1197
Friday	0.0316	0.0281	0.0239	0.0164	0.0389

Note: [a] Indicates time periods excluding October 1987

Table 9: Day of the Week Effect OLS Model

	1987-1997	1987-1997[a]	1987-1991	1987-1991[a]	1992-1997
PANEL A: ISEQ Index					
Monday	0.0282	0.0391	0.0892	0.1172	-0.0354
	(0.555)	(0.8714)	(1.168)	(1.621)	(-0.6585)
Tuesday	-0.0245	0.0093	-0.1610	-0.0923	0.1034
	(-0.5184)	(0.2346)	(-1.89)*	(-1.383)	(2.371)**
Wednesday	0.0740	0.0839	0.0535	0.0736	0.0935
	(1.57)	(1.969)**	(0.6549)	(1.045)	(1.885)*
Thursday	0.1026	0.1098	0.1038	0.1189	0.1015
	(2.407)**	(2.689)***	(1.318)	(1.587)	(2.668)***
Friday	0.0314	0.0315	0.0232	0.0234	0.0391
	(0.852)	(0.8932)	(0.3819)	(0.4102)	(0.91)
F-Statistic	1.903*	2.669**	1.618	1.783	3.195***
PANEL B: Equally Weighted Index					
Monday	0.0366	0.0366	0.1189	0.1158	-0.0432
	(0.6734)	(0.7201)	(1.2968)	(1.4441)	(-0.7147)
Tuesday	0.0482	0.0828	-0.0444	0.0264	0.1350
	(0.9336)	(1.7146)*	(-0.5049)	(0.3319)	(2.3789)**
Wednesday	0.0740	0.0904	0.0428	0.0764	0.1035

	(1.4305)	(1.8688)*	(0.4877)	(0.9603)	(1.8167)*
Thursday	0.1149	0.1152	0.1020	0.1023	0.1268
	(2.2357)**	(2.3950)**	(1.1609)	(1.2838)	(2.2556)**
Friday	0.0322	0.0287	0.0252	0.0178	0.0389
	(0.6183)	(0.5885)	(0.2847)	(0.2209)	(0.6774)
F-Statistic	0.3458	0.4540	0.4302	0.2501	1.2919

Notes:

[a] Indicates time periods excluding October 1987

*** Indicates significance at a 1per cent level

** Indicates significance at a 5 per cent level

* Indicates significance at a 10 per cent level

Figures in parentheses are the t-statistics

Table 8 provides details of the mean day return over the five periods examined. With regard to the possible Tuesday effect, it can be seen that in three of the five periods the ISEQ produces a negative mean return on Tuesday. However, one of the periods that does not produce such a result is the second sub-period from 1992 to 1997. Similar results are also found for the equally weighted index. While this series has a negative mean Tuesday return for the period 1987 to 1991, the negative return occurs on a Monday post-1991. These preliminary findings would initially indicate that there has been a structural change in the Irish market during the nineties. To examine further any possible day of the week effect, the following OLS model is used:

$$r_i = \sum_{i=1}^{5} D_i \tag{12}$$

Where r_i is the return and D_i is a dummy variable for day *i*, while the intercept is constrained to be zero. The findings, reported in **Table 9**, are not as convincing as those reported in studies such as Donnelly (1991) and Lucey (1994). As the mean daily returns indicate, the results are stronger for the first sub-period (up to 1991). During this time period the ISEQ data, including the 1987 crash, produces a significant negative Tuesday coefficient, in line with previous studies. However, when the October 1987 period is excluded from the data, and when the overall sample is examined, the coefficient is no longer significant at conventional levels. With regard to the equally weighted portfolio, none of the above periods produce significant negative coefficients (i.e. none of the periods provide significant negative coefficients for Tuesdays for the large firm sample), indeed the data for the whole sample period results in a significant positive coefficient. Both series also produce such results for the period 1992 to 1997. It is also of interest that in the same period both series produce negative Monday coefficients, in line with international evidence concerning a weekend effect; however, in neither case is the coefficient significant.

Table 10: Mean Monthly Returns

	1987-1997	1987-1991	1992-1997
PANEL A: ISEQ Index			
January	0.26816	0.31458	0.22942
February	0.11154	0.25083	-0.000473
March	0.09108	0.15143	0.04055
April	0.05269	-0.0679	0.15384
May	0.0651	0.15311	-0.0279
June	0.01065	0.02057	0.00004361
July	0.1249	0.21389	0.0351
August	-0.0379	-0.2024	0.13128
September	-0.0526	-0.0262	-0.0787
October	-0.1149	-0.2845	0.04328
November	-0.1556	-0.3971	0.0859
December	0.1135	0.10837	0.11607
PANEL B: Equally Weighted Index			
January	0.309357	0.394644	0.247859
February	0.146822	0.276263	0.038777
March	0.1036	0.193985	0.027911
April	0.067763	-0.074133	0.186812

May	0.07418	0.171598	-0.028753
June	0.026365	0.028289	0.024382
July	0.147247	0.218759	0.075080
August	-0.053666	-0.235559	0.133473
September	-0.076102	-0.083994	-0.068333
October	-0.034996	-0.113921	0.038616
November	-0.082797	-0.280154	0.112561
December	0.078917	0.080680	0.097498

Note: The adjusted figures for October for the two time periods excluding the 1987 crash are 0.04917 (1987-1997) and 0.05694 (1987-1991)

The second seasonality hypothesis is primarily concerned with the possible presence of a January effect. A number of hypotheses have been proposed concerning the presence of abnormal returns in January, the prominent one being a tax-year effect. This hypothesis was based on initial US empirical evidence and was concerned with tax-driven selling at the end of the year, with securities being re-purchased in January. However, as with evidence from a number of other countries, existing Irish evidence has also found evidence of a January effect, despite the tax year not being calendar based. Other alternative hypotheses include 'window dressing' by portfolio managers for end-of-year reporting and a link with the small firm effect. To re-appraise the January effect in an Irish context we use the following model:

$$r_i = \sum_{i=1}^{12} M_i \qquad (13)$$

Where r_i is the return and M_i is a dummy variable for month *i*. As with the daily seasonality model, the intercept is constrained to be zero. **Table 10** presents the mean monthly returns, while **Tables 11 and 12** report the results from equation (13) using both the ISEQ and the equally weighted series respectively. It can be seen that in every case the mean January returns are higher than every other month, results confirmed by the regression coefficients reported in **Tables 11 and 12**. For both the ISEQ and equally weighted data, the January coefficient is significant in the Irish market. These results highlight two key issues. Firstly, that in Ireland the January effect is not tax driven due to the presence of a non-calendar tax year and, secondly, that it would appear unlikely that the effect is driven by movements in small firms. Using US data, Keim (1983) found that over 25 per cent of the differential between small and large stocks occurred within the first five trading days of January. However, in the current study the equally weighted index of large firms has significant January coefficients. Indeed, for all three sample periods the mean January return for the equally weighted portfolio is higher than that for the ISEQ. It would therefore appear that the most likely cause for the January effect in the Irish market is window dressing by fund managers. The fact that for both the overall time frame and the first sub-sample, both series analysed have significantly positive July coefficients, indicates a degree of allocation switches around the time of mid-year reporting.

Table 11: Month of the Year Effects, ISEQ Index

	1987-1997	1987-1991	1992-1997
January	0.2682	0.3146	0.2942
	(4.082)***	(2.771)***	(3.086)***
February	0.1115	0.2508	-0.0047
	(1.847)*	(2.893)***	(-0.0574)
March	0.0911	0.1514	0.0406
	(1.536)	(1.654)*	(0.5255)
April	0.0527	-0.0679	0.1538
	(0.7825)	(-0.5448)	(2.371)**
May	0.0651	0.1531	-0.0279
	(1.36)	(2.075)**	(0.4743)
June	0.0107	0.0206	0.0004
	(0.2587)	(0.3453)	(0.0077)
July	0.1249	0.2139	0.0351
	(2.473)**	(2.716)***	(0.5669)
August	-0.0379	-0.2024	0.1313
	(-0.531)	(1.641)	(1.988)**
September	-0.0526	-0.0262	-0.0787
	(-1.077)	(-0.3808)	(-1.138)

October	-0.1149	-0.2845	0.0433
	(-0.9644)	(1.223)	(0.5854)
November	-0.1556	-0.3971	0.0859
	(-1.729)*	(-2.467)**	(1.169)
December	0.1135	0.1084	0.1185
	(1.712)*	(0.9427)	(1.758)*
F-Statistic	3.135***	3.303***	2.230***

Notes:

*** Indicates significance at a 1per cent level

** Indicates significance at a 5 per cent level

* Indicates significance at a 10 per cent level

Figures in parentheses are the t-statistics

The OLS regressions were corrected for heteroscedasticity. The corrected coefficients for October when 1987 was excluded from the sample were 0.00049173 (0.7448), 1987-1997 and 0.00056936 (0.4827) for 1987-1991. The corresponding F statistics were 3.159*** (1987-1997) and 3.695*** (1987-1991).

Table 12: Month of the Year Effects, Equally Weighted Index

	1987-1997	1987-1991	1992-1997
January	0.3096	0.3835	0.2479
	(4.004)***	(2.8392)***	(2.9880)***
February	0.1468	0.2763	0.0388
	(1.8537)**	(1.9966)**	(0.4563)
March	0.1036	0.1940	0.0279
	(1.3197)	(1.4158)	(0.3311)
April	0.0678	-0.0741	0.1868
	(0.8459)	(-0.5305)	(2.1708)**
May	0.0742	0.1716	-0.0288
	(0.9281)	(1.3060)	(-0.3167)
June	0.0264	0.0283	0.0244
	(0.3167)	(0.2055)	(0.2595)
July	0.1472	0.2188	0.0751
	(1.8465)*	(1.6500)*	(0.8385)
August	-0.0537	-0.2356	0.1335
	(-0.6606)	(1.7523)*	(1.4561)
September	-0.0761	-0.0839	-0.0683
	(-0.9412)	(-0.6215)	(-0.7561)

October	-0.0350	-0.1139	0.0386
	(-04204)	(-0.8069)	(0.4213)
November	-0.0838	-0.2802	0.1126
	(-1.0436)	(-2.0938)**	(1.2514)
December	0.0789	0.0807	0.0772
	(0.9218)	(0.5625)	(0.8091)
F-Statistic	1.8894**	2.1783**	0.9480

Notes:

*** Indicates significance at a 1per cent level

** Indicates significance at a 5 per cent level

* Indicates significance at a 10 per cent level

Figures in parentheses are the t-statistics

The OLS regressions were corrected for heteroscedasticity. The corrected coefficients for October when 1987 was excluded from the sample were 0.0917 (1.1278), 1987-1997, and 0.1615 (1.1498) for 1987-1991. The corresponding F statistics were 2.0402** (1987-1997) and 2.5939*** (1987-1991).

CONCLUSION

This paper has re-examined the efficiency of the Irish equity market using a variety of methods and techniques over a ten-year period. In addition, in order to account for possible biases due to thin trading, the tests are re-run using an equally weighted portfolio of five heavily traded stocks. The initial tests confirm previous studies of the Irish market, with evidence that it does not conform with weak-form market efficiency. The results for the runs tests, autocorrelation coefficients, unit root and variance ratio tests, all produce evidence to this effect. With regard to seasonalities, there is relatively strong evidence that there exists a January effect in the Irish market. In the presence of a non-calendar tax year, and the absence of differences in the results for the large capitalisation stocks examined, these findings would appear to indicate that this effect is due to factors such as fund managers altering portfolio allocations prior to end-of-year reporting. Evidence of a July effect further substantiates this hypothesis. The results with regard to daily seasonalities differ quite substantially from previous studies, with the absence of a Tuesday effect in the period post-1991.

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NOTES

[1]The detailed results for the other time periods are available from the author on request.

[2]Note that only the results for the heteroscedasticity-consistent variance estimators are reported.

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